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REPORT

OF THE

SUPERINTENDENT

OF THE

UNITED STATES COAST SURVEY,

SHOWING

THE PROGRESS OF THE SURVEY

DURING

THE YEAR 1865.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1867.

REPORT.

COAST SURVEY OFFICE,
Washington, D. C., December 16, 1865.

SIR: I have the honor to report, in accordance with law and the regulations of the Treasury Department, on the progress made in the survey of the coasts of the United States during the year from November 1, 1864, to November 1, 1865.

During the rebellion the usual field operations of the coast survey were necessarily somewhat restricted. In the southern sections they were carried on only as far as requisite and practicable in connection with the operations of the naval forces. In most cases when the assistants and aids have served with military or naval commands, the working parties have been furnished from the command, and only the pay and subsistence of the officers of the survey have been chargeable to the coast survey appropriations. So also the vessels of the survey, when serving with squadrons, have been supplied with coal and kept in repair by the Navy Department.

Under these circumstances a corresponding reduction in the estimates for the work was made, which, from considerations of economy, was extended to the work on the western coast. The appropriations, amounting to over four hundred and fifty thousand dollars in 1860, were reduced, in accordance with the estimates submitted, to about three hundred thousand dollars during the several years of the war.

The general progress made in the survey of the coast, and in the development of its hydrographic features, is best shown by the sketch which has been given from year to year with the annual reports. That sketch accompanies this report as No. 25 in the list of maps and charts, which give the most recent results of the survey. The large manuscript map presented from year to year, in accordance with the act of Congress approved March 3, 1853, shows the same particulars in more detail. By either of these maps the condition of the work in its general features can be seen at a glance.

DIVISIONS OF THE REPORT.

The usual subdivision of the annual report into three parts is retained. Part I, as heretofore, will contain statements of particulars connected with the field and office work of the survey—such as estimates, progress, and remarks on special results. Part II will contain notices of the work done by each party in the field and the details of occupation in each branch of the office. In the Appendix (Part III) will be given general lists illustrating the field and office work, and papers descriptive of methods and processes connected with geodetic operations. These last, being of special interest, will be briefly reviewed in Part I of the report.

PROGRESS DURING THE SURVEYING YEAR 1864-'65.

The following is a brief sketch of the progress made during the past year. While the war continued, a number of parties were connected with government commands, and rendered efficient aid in naval and military operations, as during the preceding years.

Four parties were attached to the South Atlantic blockading squadron, so as to be available also for service in the military departments of the south. The labors of these comprise a complete resurvey of the bar and channels leading into Charleston harbor; a survey of the inside water passages between St. Helena and Port Royal sounds, and a survey of Broad river and the Whale branch to Port Royal ferry; of the Wilmington and Thunderbolt rivers, and other communications between the Savannah river and Ossabaw sound, including among them the dependencies of Wassaw sound; a survey of the rebel defences of Charles-

ton and Savannah, the latter embraced within an extended reconnaissance of all the approaches to that city. In this same district, and under instructions of the Light-house Board, the parties have replaced lights, beacons, and buoys, as their places were re-occupied by the national forces. The entrance to Darien was examined and buoyed, for the transportation of released Union prisoners.

Four topographers of the coast survey accompanied General Sherman's army in the march from Savannah to Goldsboro', and rendered effective aid in making reconnaissances.

Two parties were connected with the North Atlantic blockading squadron. One of these, after assisting in the operations against the rebel defences of Wilmington, North Carolina, made a complete resurvey of both entrances to the Cape Fear river. The other relighted and buoyed the channels of that river, as also those leading into Beaufort, North Carolina, which was then important as the rendezvous of the squadron for supplies. After the close of hostilities the same party completed the hydrographic survey of the Cape Lookout shoals, and continued off-shore soundings along the coast of North Carolina.

A topographical survey of the banks of the Potomac river, from the vicinity of Washington to Harper's Ferry, has been made by a party attached to the middle military department; and two other parties have extended the detailed surveys of the approaches to Washington and Baltimore. One topographer was continued on service with the army operating in the valley of Virginia, and furnished the results of reconnaissances at Flint Hill and Cedar creek, after serving in battle at both places. Another remained on duty with the army of the Tennessee, and has mapped the defensive ground and approaches to Lookout mountain, and extended the survey of the battle-field of Chickamauga.

In connexion with the Mississippi squadron, a party of coast survey officers have made a valuable reconnaissance map of over two hundred and fifty miles of the Tennessee river, or from its mouth to the Muscle shoals; a map of the lower Ohio from Paducah to Cairo; and a map of about one hundred and fifteen miles of the course of the Mississippi river from Cairo up to St. Mary's. This work necessarily ceased when, owing to the reduction of the squadron in the western waters, a vessel was no longer available for the uses of the party. It may be hoped, however, that the great and obvious usefulness, in a national point of view, of a reliable map of the Mississippi river may lead Congress to make a special appropriation for the further prosecution of that work. A stretch of forty-five miles of the river was mapped last year above and below Vicksburg, and thus an important part of the Mississippi has already been surveyed without involving any public expenditure that would not otherwise have been incurred.

In the regular progress of the survey of the Atlantic coast, parties have been at work on the coast of Maine during the summer and autumn, in Passamaquoddy, Gouldsborough, Frenchman's and Penobscot bays, in Muscongus sound, and in the Medomak, Damariscotta, and New Meadow rivers; on the shores of Narragansett bay and its dependencies, in Rhode Island; and on the coast of New Jersey. The connection of the primary triangulation in Sections I and II has been completed by the Superintendent's party.

On the western coast, the triangulation between San Francisco and Monterey bays has been completed; that of Suisun bay has been continued; the topography between Point Año Nuevo and Point San Pedro, and the off-shore hydrography south of San Francisco entrance, have been continued, and the topography and hydrography of Koos bay have been completed.

Under the head of sections geographically arranged, the details of work done by the surveying parties will be found in Part II of this report, followed by a summary of the work done in the office during the year.

ESTIMATES.

The estimates for the deficiency in appropriations for the survey of the coast for the fiscal year 1865–'66, together with those for the fiscal year 1866–'67, are herewith appended.

In regard to the deficiency it is only necessary to state that the late Congress failed to pass the general appropriation bill, in which the items for the coast survey were included. No appropriation, therefore, was made for the fiscal year 1865–'66. The work has been continued with the unexpended balance of previous appropriations, and some aid afforded by the Treasury Department. During the progress of the bill in the late Congress, the estimates for the work of the survey had been approved by both houses, and the amounts now estimated for are intended to meet the expenditures for the remainder of the present fiscal year, upon the same scale of appropriation.

An early resumption of the work on the coast of the southern States is contemplated, and is provided for on a moderate scale in the estimates herewith presented.

The table below gives the amounts estimated to supply the deficiency for the fiscal year 1865–'66, in

parallel columns, with the estimates which were originally submitted for the whole fiscal year, and which, though approved by both houses of Congress at the last session, failed to become a law before the expiration of that session.

Object.	Estimate for fiscal year 1865–'66, but not appropriated.	Estimate for deficiency.
For survey of the Atlantic and Gulf coasts of the United States, including compensation of civilians engaged in the work, per act of March 3, 1843	$181,000	$120,000
For continuing the survey of the western coast of the United States, including conpensation of civilians engaged in the work, per act of September 30, 1850	100,000	75,000
For continuing the survey of the reefs, shoals, keys, and coast of south Florida, including compensation of civilians engaged in the work, per act of March 3, 1849	11,000	11,000
For publishing the observations made in the progress of the survey of the coast of the United States, including compensation of civilians engaged in the work, per act of March 3, 1843	4,000	4,000
For repairs of steamers and sailing schooners used in the survey, per act of March 2, 1853	20,000	20,000
For pay and rations of engineers for three steamers used in the hydrography of the coast survey, no longer supplied by the Navy Department	6,000	6,000
Total	322,000	236,000

The estimates presented for the fiscal year 1866–'67 approach more nearly to the scale of expenditure before the war. They contemplate the continuance of work in the southern sections, which, besides being called for to aid in the development of the resources of that part of our country, will be conducive to economy, since it will, as formerly, enable the same parties to push the work on the southern coast during winter, after closing work for the season at the north. Without any material increase in the salaries and office expenses, the amount of field-work accomplished will be far more than proportionably augmented.

Owing to the great increase in the price of labor and supplies of every kind, the appropriations asked for, although the same in amount of the two principal items as those for 1860–'61, will not be equivalent to the latter, yet they are as low as is consistent with an economical prosecution of the work in the several localities where it has been commenced.

The item providing for the continuation of the survey of the Florida reefs and keys has been diminished from forty to twenty-five thousand dollars, because that important work is proportionally far advanced towards completion. The item providing for repairs of vessels, on the contrary, is unavoidably increased by reason of the great increase in the cost of such repairs, and because a larger amount of refitting is at present necessary, on account of the greater wear and tear during the war.

The estimates for progress on the Atlantic, Gulf coast, Florida reefs, and western coast of the United States are given, as usual, in separate items, and are preceded by a detailed statement of the progress contemplated in the several sections of the work.

Estimates in detail for the fiscal year 1866–'67.

For general expenses of all the sections, namely: rent, fuel, materials for drawing, engraving and printing, and for transportation of instruments, maps, and charts; for miscellaneous office expenses, and for the purchase of new instruments, books, maps, and charts $21,000

SECTION I. *Coast of Maine, New Hampshire, Massachusetts, and Rhode Island.* FIELD-WORK.—To continue the triangulation of *Passamaquoddy bay*, and extend it so as to include the northeastern boundary along the *St. Croix river;* to complete the secondary triangulation of the coast of Maine, west of *Mount Desert island;* to continue the topography of *Passamaquoddy bay* and its dependencies; to continue that of *Gouldsborough bay*, that of the islands at the entrance of *Penobscot bay*, and the western shore of the bay above *Camden;* that of the adjacent shores of *Muscongus sound* and *Medomak river;* to complete the topography of the *Damariscotta river*, and the survey of the eastern shores of *Casco bay;* to continue that of the coast of *New Hampshire*, between *Great Boar's Head* and *Portsmouth*, and to complete that

of the shores of *Massachusetts bay* between *Sandwich* and *Plymouth;* to continue the detailed survey of the shores and islands of *Narragansett bay;* to continue off-shore soundings along the coast of Maine, and the hydrography of *Passamaquoddy bay, Frenchman's bay, Gouldsborough bay, Prospect and Winter harbors,* and the approaches to *Penobscot bay;* to continue tidal and magnetic observations at Portland, and tidal observations in the progress of the hydrography. OFFICE-WORK.—To make the computations required for, and reductions from, the field observations; to continue the drawing of coast chart No. 1, *Passamaquoddy bay;* to continue the drawing and engraving of coast chart No. 6, approaches of *Penobscot bay;* of No. 7, *Pemaquid Point* to *Cape Elizabeth;* of No. 8, approaches to *Casco bay;* of No. 10, coast of Massachusetts from *Cape Ann* to *Plymouth;* of No. 11, *Cape Cod bay,* and of No. 14, *Narragansett bay and approaches;* to continue the drawing and engraving of general coast chart No. 1, *Quoddy Head, Me., to Cape Cod, Mass.;* to complete the drawing and engraving of charts of *Rockland, Camden, and Rockport harbors;* to continue the drawing and engraving of *Eastport harbor, Winter harbor, Tennant's harbor* and *Herring gut,* of *St. George's river,* and *Muscle Ridge channel,* and of the *Damariscotta river;* and to complete the drawing and engraving of charts of the *Sheepscot river, Me.,* of *Newport harbor,* and of *Providence river, R. I.,* and to engrave the resurvey of *Boston harbor,* will require $43,000

SECTION II. *Coast of Connecticut, New York, New Jersey, Pennsylvania, and part of Delaware.* FIELD-WORK.—To make supplementary astronomical observations to continue the triangulation of *Connecticut river,* between Higganam and Hartford, and that of the *Thames river* above *New London;* to continue verification work on the *coast of New Jersey,* south of Absecom inlet; to continue the topography of the shores of the *Connecticut;* to execute such supplementary hydrography as may be required in *New York bay and Delaware bay;* to continue the tidal observations. OFFICE-WORK.—To make the computations and reductions; to complete the engraving of coast chart No. 21, *New York harbor* and its approaches, (new edition,) and to commence the drawing and engraving of coast chart No. 22, from *Sandy Hook to Barnegat;* and to complete the engraving of coast chart No. 28, from *Cape May, N. J.,* to *Isle of Wight, Del.,* will require 15,000

SECTION III. *Coast of part of Delaware and that of Maryland and part of Virginia.* FIELD-WORK.—To continue astronomical and magnetic observations in the section, and secure the stations of the triangulation; to make extensions of the triangulation for including the detached plane-table surveys in the vicinity of *Washington city;* to complete the topography near *Washington,* required for defensive purposes, and continue that of the eastern shore of Virginia; to make such detailed surveys as may be necessary at points on the *Potomac, Rappahannock, and James rivers;* and to continue the off-shore hydrography and tidal observations in the section. OFFICE-WORK.—To make the computations from field-work; to continue the engraving of coast chart No. 29, (from *Isle of Wight, Del., to Chincoteague, Va.,*) and of No. 30, (from *Chincoteague to Great Machipongo inlet, Va.;*) to continue the engraving of coast chart No. 30 *bis,* (*Chesapeake entrance,*) and general coast chart No. IV, (approaches to Delaware and Chesapeake bays;) and to commence the drawing and engraving of a chart of *James river* from *Newport News* to *City Point,* will require 20,000

SECTION IV. *Coast of part of Virginia and part of North Carolina.* FIELD-WORK.—To complete, if practicable, the primary triangulation of *Pamlico sound,* and make the requisite astronomical and magnetic observations; to continue the triangulation of *Pamlico river;* to continue the triangulation and topography of the shores of *Neuse river;* to complete the topography of the outer coast of *North Carolina,* between *Hatteras inlet* and *Core sound;* to continue the in-shore and off-shore hydrography in the vicinity of *Cape Lookout;* and to execute that of *Pamlico river,* and such other soundings as may be required in the waters of *Pamlico* and *Albemarle sounds;* to make observations of the tides and currents. OFFICE WORK.—To make the computations and reductions; to continue the drawing and commence the engraving of general coast chart No. V, from Cape Henry to Cape Lookout; to continue the engraving of coast chart No. 38, (from Currituck, Va., to New inlet, N. C.,) and of coast charts Nos. 46 and 47, (from Cape Lookout to Barren inlet,) and the drawing and engraving of charts

of *Pamlico sound*, and of the *Neuse and Pamlico rivers;* and to complete the engraving of coast chart No. 48, Cape Fear and approaches, will require $30,000

SECTION V. *Coast of part of North Carolina and that of South Carolina and Georgia.* FIELD-WORK.—To continue the secondary triangulation of the coast of *Georgia;* to continue the topography of *Port Royal sound*, and of the islands and interior passages between it and *St. Helena sound;* to continue that of the shores of *Wassaw sound* and *Ossabaw sound* and of the rivers connecting them, and to join with the work on the passages from *Savannah river;* to complete the re-survey of *Charleston bar* and of the entrance to *Savannah river;* to complete the hydrography of *Wassaw sound* and its dependencies, connecting with *Tybee entrance* and *Savannah river*, and if practicable, to begin that of *St. Andrew's sound;* to connect the hydrography of *Doboy entrance* with the in-shore work between *Capelo and St. Simon's;* to continue the tidal observations at *Hilton Head* and *St. Mary's river entrance.* OFFICE-WORK.—To continue the engraving of coast chart No. 53, (from Rattlesnake shoal to St. Helena sound, S. C.;) to continue the drawing and engraving of No. 54, (from Fripp's inlet, S. C., to Ossabaw sound, Ga.;) to continue the drawing of No. 57, (from Sapelo sound to St. Andrew's sound, Ga.,) and that of general coast chart No. VII, (from Winyah bay, S. C., to St. John's river, Fla.,) and continue the engraving of the last-named chart; the resurvey of *Charleston harbor entrance*, and the drawing and engraving of the inland passages between St. Helena and Port Royal sounds, S. C., and of Wassaw sound, and the inland tide-water communications on the coast of Georgia, will require..... 32,600

SECTION VI. *Coast, keys, and reefs of Florida.*—(See estimates of appropriation for these special objects.)

SECTION VII. *Part of the western coast of the Florida peninsula and part of the northern coast of Florida.* FIELD-WORK.—To continue the triangulation from the *Auclote keys* towards *Tampa bay*, and from *Cape St. Blas* towards *St. Andrew's bay;* to complete the triangulation across the neck of the peninsula from *Fernandina* to *Cedar keys;* to make such astronomical and magnetic observations as may be practicable in the section; to continue the coast topography from *Bayport* southward, and that of the shore of *St. Vincent's sound* westward towards *Cape San Blas;* to re-examine the hydrography of the entrance to *Appalachicola* and *St. Mark's;* to complete the hydrography of St. George's sound, and continue that south of *Cedar keys;* to make the requisite tidal observations. OFFICE-WORK.—To deduce results by computations; to continue the drawing and engraving of coast chart No. 81, coast of Florida, from *Chassahowitzka river* to *Cedar keys;* to complete the drawing of No. 85, *St. George's sound*, (eastern part;) to continue the drawing and commence the engraving of off-shore chart No. XIII, coast of Florida, from *Waccasassa river* to *Choctawhatchee river*, and that of coast chart No. 84, Florida coast, from *Ocilla river* to *Crooked river*, (St. George's sound,) will require..... 30,000

SECTION VIII. *Coast of Alabama, Mississippi, and part of Louisiana.* FIELD-WORK.—To continue the astronomical (including longitude) and magnetic observations required in the section; to complete the triangulation and topography of the *Mississippi delta*, and extend the survey up the river towards *New Orleans;* to commence the triangulation at *Point au Fer*, and extend it towards *Ship shoal* and *Isle Derniére*, and to keep up the topography; to continue the hydrography of *Chandeleur* and *Isle au Breton sounds;* to complete that of the *Mississippi Passes* and of *Lake Pontchartrain*, and to make the tidal and current observations required. OFFICE-WORK.—To continue computations; to continue the drawing and engraving of off-shore chart No. XIV, Gulf coast, from *Choctawhatchee river to the Mississippi delta;* to continue the drawing and engraving of the chart of *Lakes Borgne* and *Pontchartrain*, (coast chart No. 93,) and to commence that of the *Mississippi delta*, (coast chart No. 96,) will require..... 32,000

SECTION IX. *Part of the coast of Louisiana and coast of Texas.* FIELD-WORK.—To make the requisite astronomical and magnetic observations, and to measure, if practicable, a primary base line and one of verification; to continue the triangulation of *Madre lagoon* and *Padre island* southward towards the boundary; to continue the topography of *Nueces* and *Corpus Christi bays*, and that of the coast southward; to complete the hydrography of *Matagorda bay* and its dependencies; to make the tidal observations required. OFFICE-WORK.—To make computations; to complete the drawing and continue the engraving of coast map and chart No. 108, *Mata-*

gorda and *Lavaca bays;* to complete the topographical drawing of No. 109, Gulf coast from *Matagorda* to *Aransas Pass*, and the engraving of Nos. 106, 107, and 108, between *Galveston and Matagorda entrances*, and to continue the drawing of off-shore chart No. XVI, Gulf coast, from *Galveston to the Rio Grande*, will require $27,000

Total for Atlantic coast and Gulf of Mexico 250,000

The estimates for the Florida coast, keys, and reefs, and for the western coast of the United States, are intended to provide for the following progress:

SECTION VI. *Coast, keys, and reefs of Florida.* FIELD-WORK.—To continue the triangulation of *Indian river* and adjacent coast northward; to make such astronomical and magnetic observations as may be requisite and practicable in the section; to complete the triangulation of *Sarasota sound*, and to commence that of *Tampa bay;* to follow the triangulation of *Indian river* and the coast adjacent with the topography; to complete the topography of the southern keys; to follow the triangulation of *Sarasota sound* by the topography; to continue the hydrography between the *Dry Tortugas* and *Key West*, and to run off-shore lines from the reefs and coast of this section; to continue the hydrography of *Charlotte harbor* and its approaches; and to keep up the magnetic observations at *Key West*. OFFICE-WORK.—To compute results from field records; to continue the drawing and commence engraving of off-shore chart No. XI, western part of Florida reefs, including the *Tortugas;* to complete the engraving of chart No. 70, *Florida reefs*, between *Long key* and *Newfound Harbor key;* to complete the engraving of the chart of *Charlotte harbor entrance*, and commence that of *San Carlos bay;* to commence the drawing of coast map and chart No. 64, *Florida coast*, between *Jupiter inlet* and *Indian River inlet*, will require $25,000

SECTION X. *Coast of California.* FIELD-WORK.—To continue the coast triangulation southward of the *San Pedro base*, or northward of *Santa Barbara*, and the work for connecting the *Santa Barbara* islands by triangulation with the coast of California; to continue the triangulation northward from *Bodega*, and to execute that of *Suisun bay;* to continue the topography of the islands in *Santa Barbara channel*, that of the shore of *Bahia Ona*, that of the coast north of *Bodega Head*, and to complete that of *Suisun bay;* to complete the hydrography of *Suisun bay;* to run off-shore lines of soundings from the principal headlands of the section; to extend the in-shore hydrography northward of *Bodega*, and re-examine bars subject to change in *San Pablo bay;* to continue tidal observations at *San Diego* and *San Francisco*. OFFICE-WORK.—To make the computations from field-work; to complete the drawing and engraving of a chart of *Halfmoon bay;* the engraving of the resurvey of *Mare Island straits*, and of the upper sheet of *San Francisco bay*, and of a chart of *Suisun bay;* to continue the drawing and engraving of a general coast chart of the Pacific, (from San Diego to Point Conception,) of a chart of *San Francisco bay*, to be issued in one sheet, and of a chart of the coast from *Point Pinos* to *Bodega Head*.

Also, for the operations in—

SECTION XI. *Coast of Oregon and that of Washington Territory.* FIELD-WORK.—To make the astronomical and magnetic observations required in this section or in Section X; to continue the triangulation of *Washington sound* in connection with former work, and to make such plane-table surveys in continuation of previous work as may be practicable; to continue the hydrography in *Admiralty inlet;* to execute soundings in special localities of Oregon or Washington Territory, as may be called for by public interests; to continue tidal observations at *Astoria*, and make such as may be required by hydrography. OFFICE-WORK.—To continue the computations of field-work; to continue the drawing and engraving of surveys, as far as now made, for charts of *Koos bay, Gray's harbor, Washington sound, Admiralty inlet*, and *Puget sound*, will require 130,000

For publishing the observations made in the progress of the survey of the coast of the United States, per act of March 3, 1843 5,000

For repairs of steamers and sailing schooners used in the survey, per act of March 2, 1853.... $20,000
For pay and rations of engineers for the steamers used in the hydrography of the coast survey, and no longer supplied by the Navy Department..... 10,000

The subjoined table exhibits in parallel columns the appropriations made before the war, those during the war, and the estimates now submitted for the fiscal year 1866–'67:

Object.	Appropriated 1860–'61.	Appropriated 1864–'65.	Estimates for 1866–'67.
For survey of the Atlantic and Gulf coasts of the United States, including compensation of civilians engaged in the work, per act of March 3, 1843	$250,000	$178,000	$250,000
For continuing the survey of the western coast of the United States, including compensation of civilians engaged in the work, per act of September 30, 1850	130,000	100,000	130,000
For continuing the survey of the reefs, shoals, keys, and coast of south Florida, including compensation of civilians engaged in the work, per act of March 3, 1849	40,000	11,000	25,000
For completing the line to connect the triangulation on the Atlantic coast with that on the gulf of Mexico, across the Florida peninsula, including compensation of civilians engaged in the work, per act of March 3, 1843	5,000	.....	.....
For publishing the observations made in the progress of the survey of the coast of the United States, including compensation of civilians engaged in the work, per act of March 3, 1843	5,000	4,000	5,000
For repairs of steamers and sailing schooners used in the survey, per act of March 2, 1853	10,000	4,000	20,000
For fuel and quarters, and for mileage or transportation, for officers and enlisted soldiers of the army serving in the coast survey, in cases no longer provided for by the quartermaster's department, per act of August 31, 1852	5,000	.....	.....
For pay and rations of engineers for steamers used in the hydrography of the coast survey, no longer supplied by the Navy Department	12,800	9,000	10,000
Total	457,800	306,000	440,000

SPECIAL SURVEYS.

In the winter of 1864–'65, application was made by the government of Nicaragua, through the Department of State, for the temporary service of a corps of our skilled surveyors for a special survey of the San Juan river, and of the harbor of San Juan del Norte or Greytown. This request, made known by the Hon. Don Luis Molina, and through the Treasury Department referred to the Superintendent, was met in January by the designation of Assistant P. C. F. West for the charge of the service desired. With him were associated Mr. A. Strausz, as hydrographic assistant, Sub-Assistant Charles Hosmer, and Mr. R. E. McMath as topographers, and Messrs. H. G. Ogden and H. L. Marindin as aids. The expenditures for the work, including the compensation of the officers, were defrayed by the applicants in conformity with terms made when the party was organized.

Besides the special duty called for at the outset, surveys or examinations were made of the Colorado river, the Caño Bravo, the San Juanillo river, and of the harbors of Monkey Point, Virgin Bay, and San Juan del Sur.

The party returned to the north in July, and resumed regular duty in the northern sections of the Atlantic coast.

HYDROGRAPHIC DEVELOPMENTS.

In Appendix No. 4 will be found a description of Cape Lookout shoals, with reference to the chart (Sketch No. 12;) and Appendix No. 5 gives an interesting account of the changes that have taken place in the entrances to Cape Fear river, resulting from a comparison of its new survey (Sketch No. 13) with the former chart.

The changes in the channels over Charleston bar, resulting from the obstructions placed in the main

channel by the blockading squadron are very marked, and can be readily seen by comparing the new chart (Sketch No. 14) with the former one. The "*stone-fleet*" has entirely disappeared; but where it was placed the water has shoaled from four to six feet, while on either side of it a new channel has formed, of the same depth as the former one. This increased water-way for the ebb-stream in a direct line from the deep water of the harbor appears to have permitted the filling up of the southern *swash* or Lawford channel, at a point four miles distant from where the obstructions were placed.

TIDES.

Appendix No. 11 gives an explanation, in a new form, of the law of the tides on the western coast, illustrated by a diagram, (Sketch No. 26.) As the sequence of these phenomena is somewhat complicated, it was thought desirable to illustrate them in this manner.

The general table of tidal constants, for predicting the tides at any time at the various ports in the United States, which has appeared for several years in the annual report of the Coast Survey, is not reprinted this year. Tide tables, giving the time and height of high water on every day in the year, for all ports in the United States, are in preparation, and will be published annually hereafter.

LIST OF ORIGINAL MAPS AND CHARTS IN THE OFFICE.

A table of all original topographical maps and hydrographical charts made in the progress of the survey, and on file in the Coast Survey office, is given in Appendix No. 8. These lists will be found highly useful for reference, and will greatly facilitate calls for local information. They are arranged in geographical order, each class separately, and give the title, reference, number, and scales, as well as the name of the person by whom the survey was made.

These originals are kept in a fire-proof building, each sheet rolled up in a separate tin-tube, numbered to correspond. As no duplicates of these maps exist, it seems highly desirable that such should be provided for, and I make the suggestion that the several States should procure copies of such of them as fall within their respective boundaries, to be kept among their own archives. A small annual expenditure on the part of each seaboard State would, in a few years, suffice to cover the cost of making copies of these valuable documents.

GEOGRAPHICAL POSITIONS.

A table of geographical positions of stations, determined in the progress of the triangulation, is given in Appendix No. 9, in continuation of similar tables heretofore published in the Coast Survey reports. The table gives the latitude and longitude of each station; its distance from two other stations, and the azimuth or true bearing of the lines joining them. These positions, which form the framework of the Coast Survey charts, will be found of great convenience in joining local surveys to the great scheme of the Coast Survey, by affording bases of known length and direction. The localities of the station can be approximately seen on the progress sketches of triangulation accompanying this and other reports; their exact positions are generally well known in the neighborhood, and the specific descriptions of the marks by which each station may be identified, can always be obtained by application to the Coast Survey office.

In addition to the foregoing list of positions which have been determined trigonometrically, Appendix No. 10 gives the latitudes and longitudes of a number of places in West Virginia, and on the Mississippi, Ohio, and Tennessee rivers, which have been determined astronomically by Coast Survey parties operating in connection with the military and naval forces, as heretofore reported.

LONGITUDES.

The investigation of the subject of determination of longitude from the occultation of the Pleiades by the moon has been continued by Professor Benjamin Peirce, LL.D., of Harvard University. In Appendix No. 12 his report of progress is given, and in Appendix No. 13 the exposition of the method employed is further continued from former reports.

The reduction of the observations heretofore made for the longitudes of places in the United States by means of the electric telegraph has been continued by Dr. B. A. Gould, whose report of progress is given in Appendix No. 14, where he likewise communicates a synopsis of the observations made by him with the transit instrument of the Coast Survey, loaned to him for use in his private observatory. In the course of the work under his charge, occasion has been taken to collect and discuss the observations of the declinations

of the same standard stars, the right ascensions of which have been heretofore published; the results are given in Appendix No. 15. In the next following paper, Dr. Gould gives the corrections of some errors that had slipped into the list of circumpolar stars heretofore published, and in Appendix No. 17 he gives the results of observations of latitude made at the Cloverden station in Cambridge, the close accordance of which establishes that point as one of the best known in latitude.

MAGNETISM.

An interesting discussion of the results of magnetical observations made monthly during a series of years at Eastport, Maine, will be found in Appendix No. 18. The object of these observations was to ascertain the amount of annual and secular variations of the magnetic elements at that easternmost station of our domain. It will be seen that those results have been reached by a system of observations which does not involve a sacrifice of time and labor too great to be encountered singlehanded by persons disposed to devote some spare hours to the investigation of this important subject. It is greatly to be desired that similar observations should be made at various points throughout the country. The convenient form of magnetometer employed, which was designed by Assistant J. E. Hilgard, and constructed by Mr. W. Würdemann, is figured in Sketch No. 29.

In connection with this subject there is given a chart of the *magnetic declination* in the United States for the year 1870, (Sketch No. 27,) and a diagram showing the secular variation of the declination (Sketch No. 28) as far as ascertained. Appendix No. 19 explains the mode of construction of these charts.

TABLE OF PROJECTIONS FOR A MAP OF NORTH AMERICA.

The system of projecting maps used in the Coast Survey, being a polyconic development of the earth's surface, now generally known as the *Coast Survey projection*, is adapted to represent large areas with the least possible distortion, and is, therefore, getting into very general use for maps of all kinds. To meet the demand for data for its construction, tables have been heretofore published in the Coast Survey reports for 1853, 1856, and 1859, which cover the whole extent of the territory of the United States. In order to facilitate the construction of maps embracing the whole of North America, a similar table is given in Appendix No. 20, giving the required co-ordinates for the insertions of the meridians and parallels for every five degrees, from the equator to the pole.

Added to this table is a continuation of the table in the Coast Survey report for 1859, which gives the co-ordinates of curvature for projections for every degree of longitude to 30°, the former table extending from the equator to latitude 54°, while the present one continues the same to the poles.

GEODESY.

The primary triangulation of the coast of New England, from the vicinity of the Hudson to the St. Croix river, has been completed by the occupation of stations West Hill and Roland during the past summer. It has been executed between the years 1844 and 1865 by the party of the Superintendent, and the observations have been made in great part by himself. Near each extremity of this great chain of triangles, (see Sketch No. 1,) extending over six hundred miles, a base line has been measured—one on Fire Island beach, in the early days of the survey in 1834, by the first Superintendent, Prof. F. R. Hassler; and the other on Epping plains, in Maine, with different bars and apparatus, by the present Superintendent, Prof. A. D. Bache, in 1857. There is, besides, an intermediate base line in Massachusetts, on the line of the Boston and Providence railroad, measured in 1844 by Assistant Edmund Blunt. In Appendix No. 21 of this report will be found a discussion of these different measurements, and of the triangulation joining them, together with a comparison of results and an estimate of the ultimate accuracy attained. From this discussion we learn that the agreement of the base lines, when reduced to each other by means of the triangulation, is closer than the estimate of the unavoidable errors of observation would lead us to expect, and that consequently the estimate of accuracy derived from the agreement of the observations among themselves is fully justified.

The probable error of any assigned distance is thus found to be about equal to its three hundred thousandth part, or less than a quarter of an inch in a mile. The disagreement of the two extreme base lines, distant from each other 430 miles, is only one and two-thirds inches in the length of the Epping base.

The methods of computation are fully illustrated in the paper referred to, which closes with a final adjustment of the triangulation, such that the measured value of the base lines are preserved, and a side com-

mon to the three branches of the triangulation has the same length assigned to it from whichever base line it is derived.

The discussions and computations have been made by Assistant C. A. Schott, in consultation with and under the immediate direction of Assistant J. E. Hilgard, in charge of the office.

TOPOGRAPHY.

The *plane-table* is used in the Coast Survey as the principal instrument for mapping the topographical features of the country, and is universally recognized as the most efficient and accurate means for that purpose. Its application under various conditions, the methods of its use and styles of topographical representation, have received a great development in the practice of the topographers of the Coast Survey, and special acknowledgment is due in this respect to the comprehensive views, practical tact, and elegant taste of Assistant H. L. Whiting, whose efforts have established the high standard of topographical maps recognized in the Coast Survey.

In order to meet the frequently expressed want of a treatise on the plane-table and its use, which does not appear to be supplied by any existing book in our language, an essay on this subject has been prepared for this report by Assistant A. M. Harrison, during an interval of enforced leisure, while prevented by impaired health from more active labor in the field. Mr. Harrison acknowledges his indebtedness to many of his colleagues for contributions and aid in the preparation of this work. It forms Appendix No. 22 of this report, and is illustrated by a representation of the plane-table, on Sketch No. 30, and by a map, Sketch No. 32, which is designed as an example of a plane-table sheet, on a scale of $\frac{1}{10000}$, drawn in a style suited to the large scale of representation. As it was intended to unite on this map all the leading characteristics of country and topographical signs, it is of necessity a composition, but all its separate features are from actual surveys.

CATALOGUE OF CHARTS.

A catalogue of the charts published by the Coast Survey office was given in the report for 1864; it is also printed separately, and can be had on application to the office. The prices vary from twenty cents to one dollar per sheet, according to the size and character of the chart. A discount of thirty-three per cent. is made to agents. The sale of charts has largely increased within late years, evincing a growing appreciation of their usefulness.

The maps and charts embraced in the catalogue are of two general descriptions, which may be distinguished as *preliminary* and *finished*. The preliminary charts are those which are issued as soon after the several surveys as is consistent with accuracy of general delineation, and are designed to supply the immediate and pressing demands of navigation. The finished charts embody *all* the information furnished by the survey, including the minutest details, and embrace not only the hydrography, but the topography likewise. The two classes of charts differ in regard to the *amount* of the information which they furnish, but not in regard to the correctness of that which is given.

The charts are various in character, according to the objects which they are designed to subserve. The most important distinctions are the following:

1. *Sailing Charts*, upon a scale of $\frac{1}{1200000}$, embracing the largest area of any, and designed to enable the navigator to protract his course. Four of these cover the entire Atlantic coast of the United States, and a fifth embraces the entire coast of the Gulf of Mexico.

2. *General Charts of the Coast*, on a scale of $\frac{1}{400000}$, for off-shore navigation. These represent the shore-line and its characteristic features, so as to be readily recognized by the navigator approaching it. The entire Atlantic and Gulf coasts will be comprehended in sixteen charts of this class.

3. *Preliminary Sea-coast Charts*, on a scale of $\frac{1}{200000}$, for in-shore navigation. These will all be ultimately superseded by the more complete charts next to be named.

4. *Coast Charts* for in-shore navigation, on a scale of $\frac{1}{80000}$, exhibiting with minute accuracy every natural and every permanent artificial feature, above or below the water, which can be introduced without occasioning confusion. They exhibit, also, the topography for some distance from the shore.

Besides the foregoing, there are numerous charts of harbors, bays, anchorages, &c., and sketches of local dangers, on various scales.